

Test Report

Report Number: F136258E1

Applicant:

Pepperl + Fuchs Inc.

Manufacturer:

Pepperl + Fuchs GmbH

Equipment under Test (EUT):

IUH-F190-V1-FR2-02





Laboratory (CAB) accredited by
Deutsche Akkreditierungsstelle GmbH (DAkkS)
in compliance with DIN EN ISO/IEC 17025
under the Reg. No. D-PL-17186-01-02,
FCC Test site registration number 90877 and
Industry Canada Test site registration IC3469A-1

REFERENCES

- [1] **ANSI C63.4-2009** American National Standard for Methods of Measuring of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- [2] **FCC CFR 47 Part 15 (January 2014)** Radio Frequency Devices
- [3] **FCC Public Notice DA 00-705 (March 2000)**
- [4] **RSS-210 Issue 8 (December 2010)** Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment
- [5] **RSS-Gen Issue 3 (December 2010)** General Requirements and Information for the Certification of Radiocommunication Equipment

TEST RESULT

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test.
The complete test results are presented in the following.

Test engineer:	Thomas KÜHN <small>Name</small>	 <small>Signature</small>	18 February 2014 <small>Date</small>
Authorized reviewer:	Bernd STEINER <small>Name</small>	 <small>Signature</small>	18 February 2014 <small>Date</small>

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1 Identification

1.1 Applicant

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Applicant represented during the test by the following person:	-

1.2 Manufacturer

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Name for contact purposes:	Mr. Jens PICHLER, Mr. Sebastian STOEBER
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eMail Address:	jpichler@de.pepperl-fuchs.com, sstoeber@de.pepperl-fuchs.com
Manufacturer represented during the test by the following person:	Mr. Jens PICHLER, Mr. Sebastian STOEBER

1.3 Test laboratory

The tests were carried out at: **PHOENIX TESTLAB GmbH**
Königswinkel 10
32825 Blomberg
Germany

accredited by DGA Deutsche Gesellschaft Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025 under Reg. No. D-PL-17186-01-02, FCC Test site registration number 90877 and Industry Canada Test site registration IC3469A-1.

1.4 EUT (Equipment Under Test)

Test object: *	UHF RFID reader
Model name: *	IUH-F190-V1-FR2-02
FCC ID: *	IREIUH-F190-V1
IC: *	7037A-IUHF190V1
Serial number: *	265719
PCB identifier: *	05-6776 + 05-6448 + 05-7025
Hardware version: *	U1
Software version: *	FCC2
Lowest internal frequency:*	484 kHz

1.5 Technical data of equipment

Channel 1	RX:	902.75 MHz	TX:	902.75 MHz
Channel 25	RX:	914.75 MHz	TX:	914.75 MHz
Channel 50	RX:	927.25 MHz	TX:	927.25 MHz

Rated RF output power: *	Max. 26 dBm (conducted)				
Antenna type: *	Internal				
Antenna gain: *	Max. 4.2 dBi				
Antenna connector: *	None				
Adaptive frequency agility: *	None				
Modulation: *	PR-ASK				
Supply Voltage: *	U _{nom} =	24.0 V DC	U _{min} =	20.0 V DC	U _{max} = 30.0 V DC
Temperature range: *	-25 °C to +70 °C				
Ancillary used for test:	During all test a connector box type IC-KP2-2HRX-2V1 was used.				

* declared by the applicant.

The following external I/O cables were used:

Identification	Connector		Length
	EUT	Ancillary	
Connector	5 pole M12 plug	5 pole M12 plug	5.0 / 2.0 m*
-	-	-	-
-	-	-	-

*: Length during the test if no other specified.

1.6 Dates

Date of receipt of test sample:	11 February 2014
Start of test:	11 February 2014
End of test:	12 February 2014

2 Operational states

All tests were carried out with an unmodified sample with integral.

During the all tests the EUT was powered by an external 24.0 V DC power supply. During the emission measurement on the AC supply line the EUT was powered by an AC / DC adaptor type PHOENIX CONTACT Mini-PS-100-240AC/24DC/1.3 via the connector box IC-KP2-2HRX-2V1. The connector box as well as the EUT was grounded during all tests in accordance to the applicant's installation instruction.

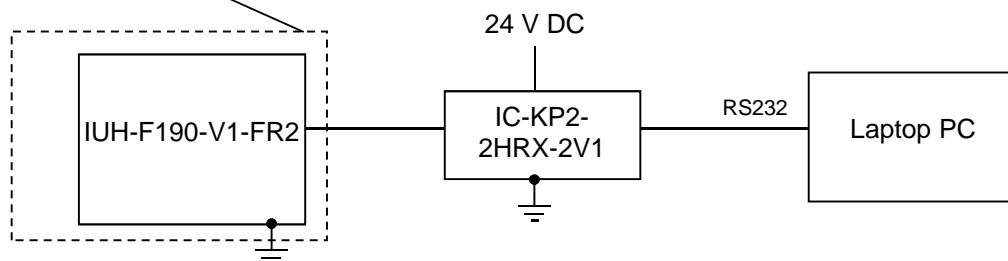
The operation mode could be chosen with the help of a laptop computer with a test-software, communicates with the EUT via the RS232.

All conducted measurements were carried out on the internal antenna port.

The following test modes were adjusted during the tests:

Operation mode	Description of the operation mode	Modulation
1	Continuous transmitting on 902.750 MHz	PR-ASK
2	Continuous transmitting on 914.750 MHz	PR-ASK
3	Continuous transmitting on 927.250 MHz	PR-ASK
4	Transmitter hopping on all channels	PR-ASK

Physical boundary of the EUT



3 Additional information

During the tests the EUT was not labelled as required by FCC / IC. During mass production the EUT will be sealed. The tested sample was unsealed.

4 Overview

Application	Frequency range [MHz]	FCC 47 CFR Part 15 section [2]	RSS 210, Issue 8 [4] or RSS-Gen, Issue 3 [5]	Status	Refer page
20 dB bandwidth	General	15.247 (a) (1) (i)	A8.1 (c) [4]	Passed	8 et seq.
Carrier frequency separation	General	15.247 (a) (1) (i)	-	Passed	11 et seq.
Number of hopping channels	902.0 – 928.0	15.247 (a) (1) (i)	A8.1 (c) [4]	Passed	14 et seq.
Dwell time	902.0 – 928.0	15.247 (a) (1) (i)	A8.1 (c) [4]	Passed	16 et seq.
Maximum peak output power	902.0 – 928.0	15.247 (b) (2)	A8.4 (1) [4]	Passed	18 et seq.
Radiated emissions (transmitter)	0.009 - 10,000	15.247 (d) 15.205 (a) 15.209 (a)	A8.5 [4] 2.5 [4] 7.2.2 [5]	Passed	21 et seq.
Conducted emissions on supply line	0.15 - 30	15.207 (a)	7.2.4 [5]	Passed	41 et seq.
Radiated emissions (receiver)	30 – 5,000	15.109 (a)	6.1 [5]	Not carried out *	-

*: No measurement of the receiver spurious emissions was carried out, because of a continuously operating co-located transmitter.

5 Test results

5.1 20 dB bandwidth

5.1.1 Method of measurement (20 dB bandwidth)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on and the hopping function has to be disabled, the transmitter shall work with its maximum data rate.

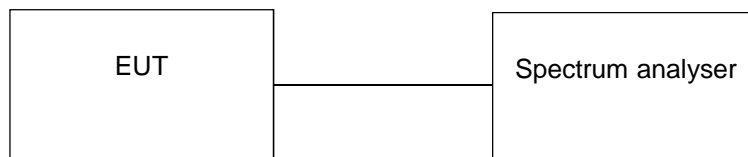
The following spectrum analyser settings shall be used:

- Span: App. 2 to 3 times the 20 dB bandwidth, centred on the actual hopping channel.
- Resolution bandwidth: $\geq 1\%$ of the 20 dB bandwidth.
- Video bandwidth: \geq the resolution bandwidth.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak. The first display line has to be set on this value. The second display line has to be set 20 dB below the first line (or the peak marker). The frequency lines shall be set on the intersection points between the second display line and the measured curve.

The measurement will be performed at the upper, the lower end and the middle of the assigned frequency band.

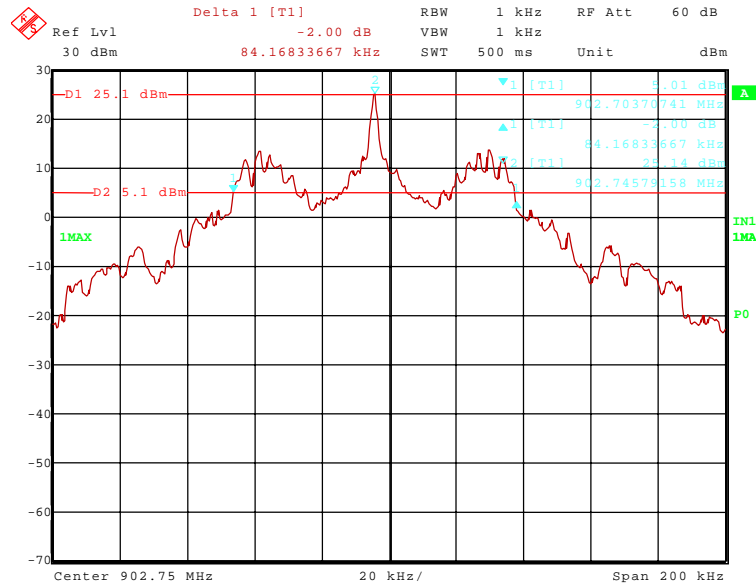
Test set-up:



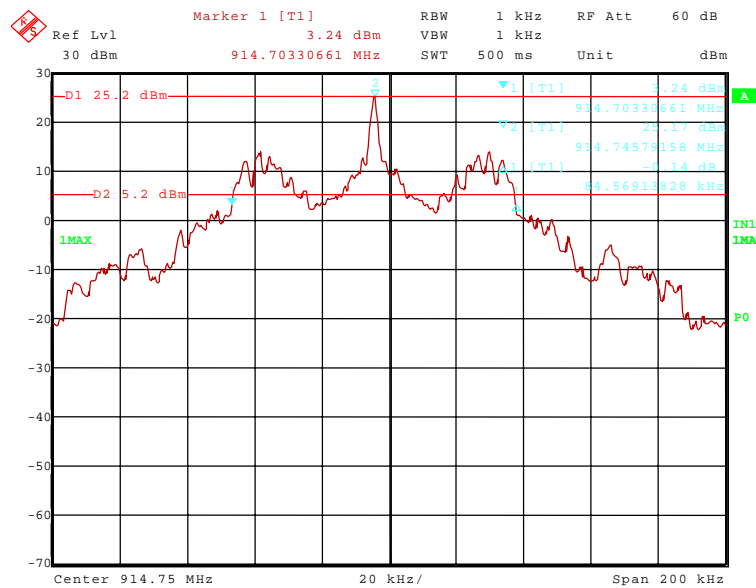
5.1.2 Test results (20 dB bandwidth)

Ambient temperature	21 °C	Relative humidity	34 %
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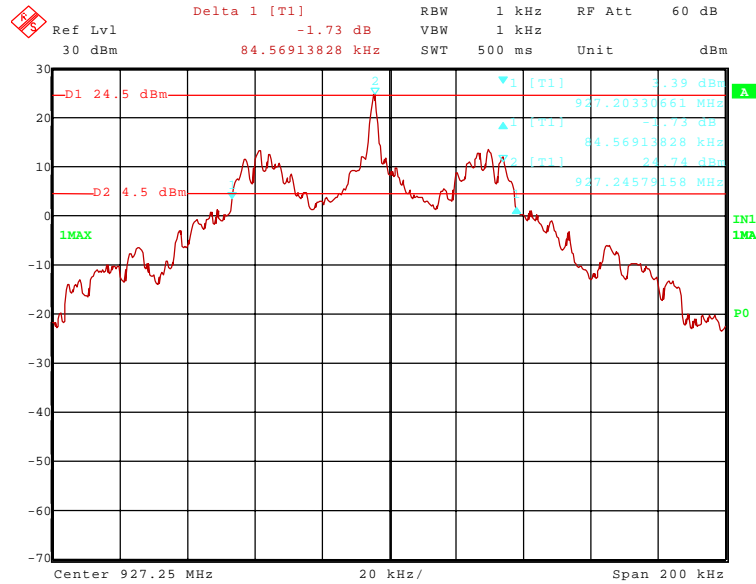
136258 16.wmf: 20 dB bandwidth at the lower end of the assigned frequency band:



136258 17.wmf: 20 dB bandwidth at the middle of the assigned frequency band:



136258_18.wmf: 20 dB bandwidth at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	20 dB bandwidth [kHz]
1	902.750	84.168
25	914.750	84.569
50	927.250	84.569
Measurement uncertainty		+0.66 dB / -0.72 dB

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31

5.2 Carrier frequency separation

5.2.1 Method of measurement (carrier frequency separation)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on and the hopping function has to be enabled.

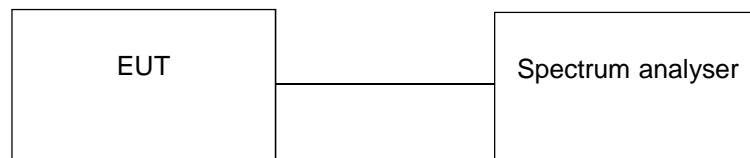
The following spectrum analyser settings shall be used:

- Span: Wide enough to capture the peaks of two adjacent channels.
- Resolution bandwidth: $\geq 1\%$ of the span.
- Video bandwidth: \geq the resolution bandwidth.
- Sweep: Auto.
- Detector function: peak.
- Trace mode: Max hold.

After trace stabilisation the marker and the delta marker function will be used to determine the separation between the peaks of two adjacent channel signals.

The measurement will be performed at the upper, the lower end and the middle of the assigned frequency band.

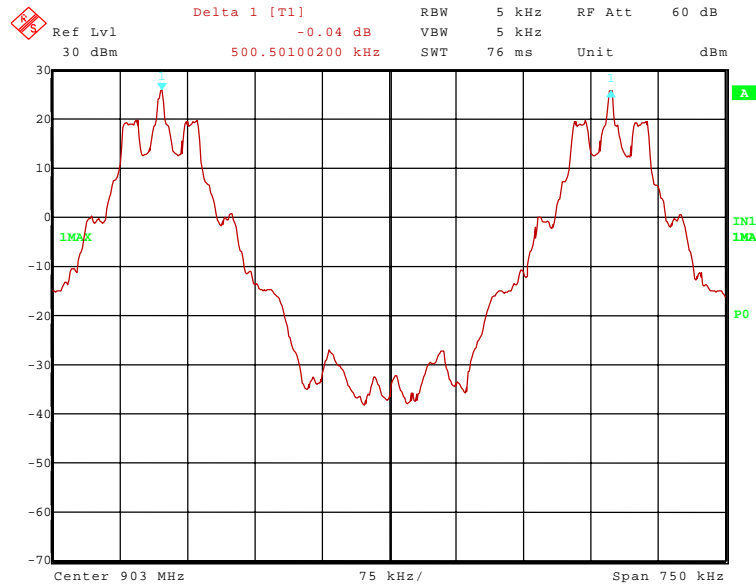
Test set-up:



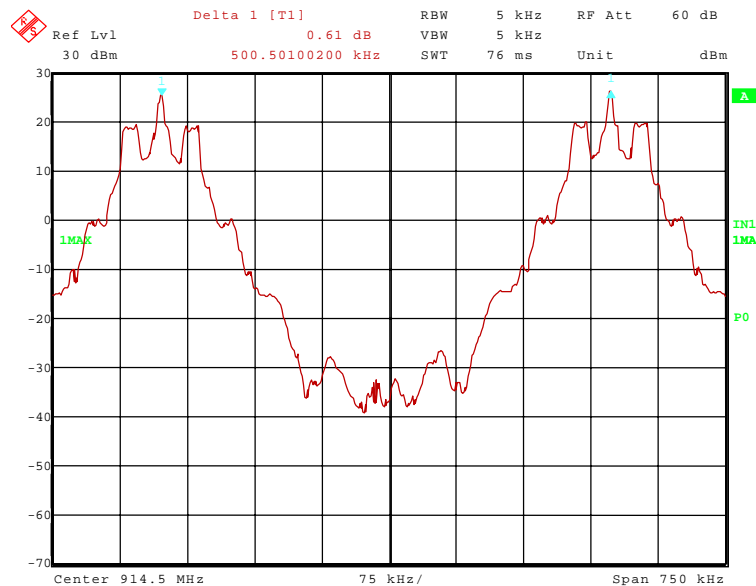
5.2.2 Test results (carrier frequency separation)

Ambient temperature	21 °C	Relative humidity	34 %
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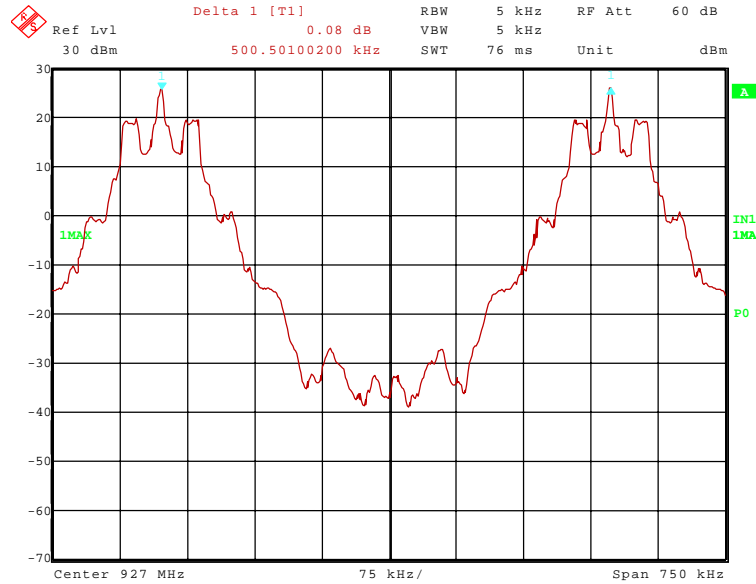
136258 19.wmf: Channel separation at the lower end of the assigned frequency band:



136258 20.wmf: Channel separation at the middle of the assigned frequency band:



136258_21.wmf: Channel separation at the upper end of the assigned frequency band:



Channel number	Channel frequency [MHz]	Channel separation [kHz]	Minimum limit [kHz]
1	902.750	500.501	84.168 (the 20 dB bandwidth)
25	914.750	500.501	84.569 (the 20 dB bandwidth)
50	927.250	500.501	84.569 (the 20 dB bandwidth)
Measurement uncertainty			$<10^{-7}$

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
31

5.3 Number of hopping frequencies

5.3.1 Method of measurement (number of hopping frequencies)

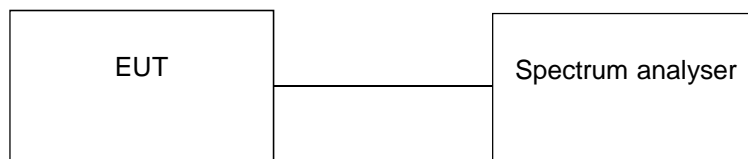
The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on and the hopping function has to be enabled.

The following spectrum analyser settings shall be used:

- Span: Equal to the assigned frequency band.
- Resolution bandwidth: $\geq 1\%$ of the span.
- Video bandwidth: \geq the resolution bandwidth.
- Sweep: Auto.
- Detector function: Peak.
- Trace mode: Max hold.

After trace stabilisation the number of hopping channels could be counted. It might be possible to divide the span into some sub ranges in order to clearly show all hopping frequencies.

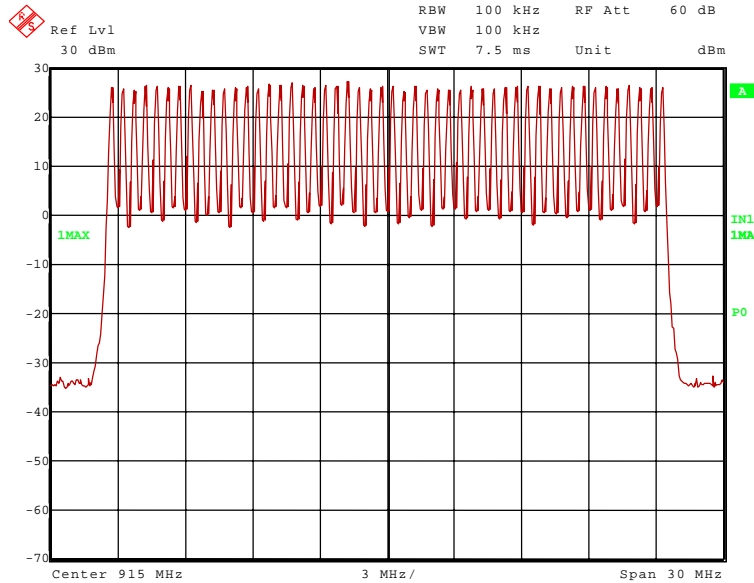
Test set-up:



5.3.2 Test results (number of hopping frequencies)

Ambient temperature	21 °C	Relative humidity	34 %
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136258 22.wmf: Number of hopping channels:



Number of hopping channels	Limit
Operation mode 4	
50	At least 50

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
31

5.4 Dwell time

5.4.1 Method of measurement (dwell time)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on and the hopping function has to be enabled.

The following spectrum analyser settings shall be used:

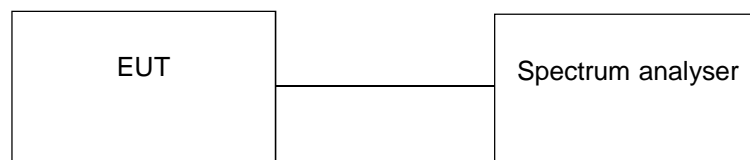
- Span: Zero, centred on a hopping channel.
- Resolution bandwidth: 1 MHz.
- Video bandwidth: \geq the resolution bandwidth.
- Sweep: As necessary to capture the entire dwell time per hopping channel.
- Detector function: peak.
- Trace mode: Max hold.

The marker and delta marker function of the spectrum analyser will be used to determine the dwell time.

The measurement will be performed at the middle of the assigned frequency band.

If the EUT is possible to operate with different mode of operation (data rates, modulation formats etc.) the test will be repeated with every different operation mode of the EUT.

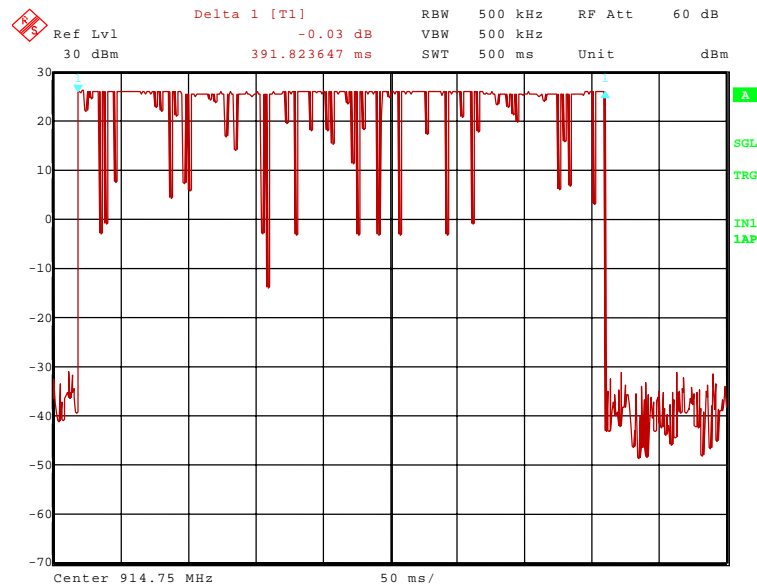
Test set-up:



5.4.2 Test results (dwell time)

Ambient temperature	21 °C	Relative humidity	34 %
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136258_23.wmf: Dwell time at the middle of the assigned frequency band:



The dwell time is calculated with the following formula:

$$\text{Dwell time} = t_{\text{pulse}} \times n_{\text{hops}} / \text{number of hopping channels} \times 20 \text{ s}$$

Where:

t_{pulse} is the measured pulse time (pls. refer the plots of the spectrum analyser above) [s],
 n_{hops} is the number of hops per second in the actual operating mode of the transmitter [1/s].

The hopping rate of the system is 2.5 hops per second and the system uses 50 channels.

Channel number	Channel frequency [MHz]	t_{pulse} [ms]	Dwell time [ms]	Limit [ms]
25	914.750	391.824	391.824	400
Measurement uncertainty			<10 ⁻⁷	

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:
31

5.5 Maximum peak output power

5.5.1 Method of measurement (maximum peak output power)

The calibration of the spectrum analyser has to be checked with the help of a known signal from a signal generator. The EUT has to be connected to the spectrum analyser via a low loss cable. If the EUT is not equipped with an antenna connector, a temporary antenna connector has to be installed. The EUT has to be switched on and the hopping function has to be disabled.

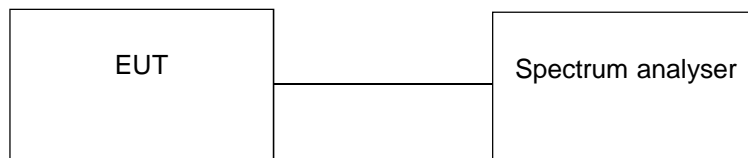
The following spectrum analyser settings shall be used:

- Span: Approx. 5 times the 20 dB bandwidth, centred on a hopping channel.
- Resolution bandwidth: > the 20 dB bandwidth of the emission being measured.
- Video bandwidth: \geq the resolution bandwidth.
- Sweep: Auto /1 s.
- Detector function: peak / average.
- Trace mode: Max hold.

After trace stabilisation the marker shall be set on the signal peak. The indicated level is the peak output power / average power, which has to be corrected with the value of the cable loss and an external attenuation (if necessary).

The measurement will be performed at the upper and lower end and the middle of the assigned frequency band.

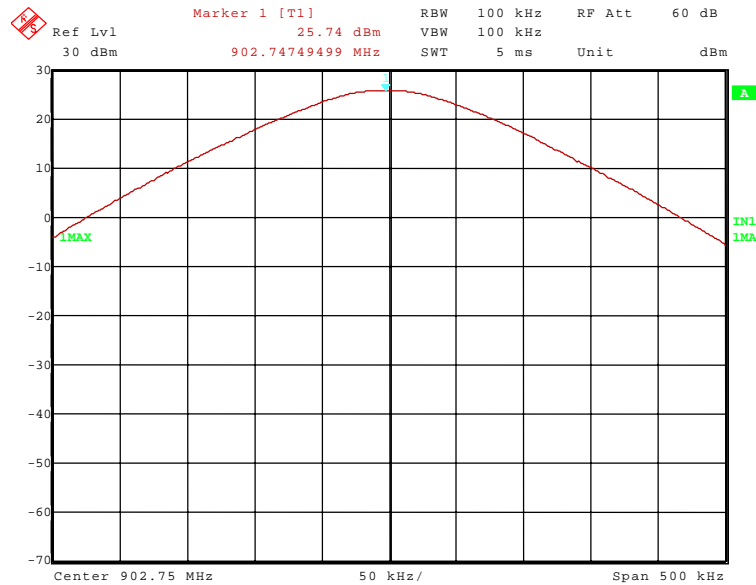
Test set-up:



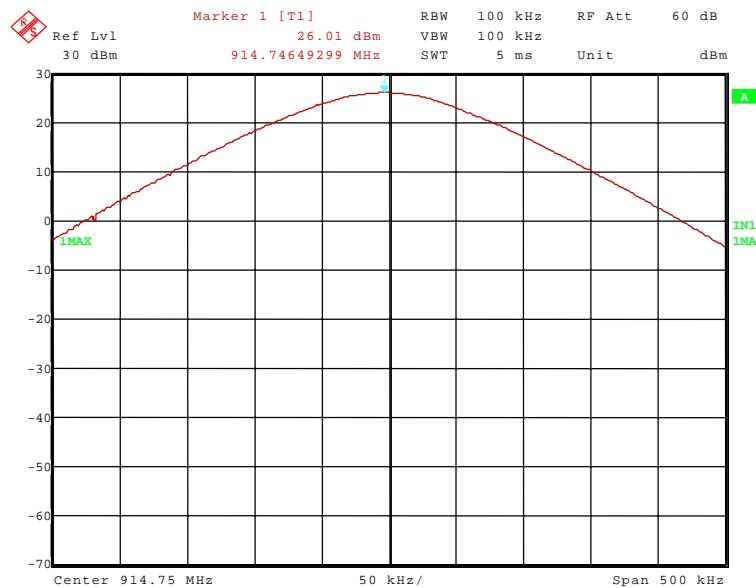
5.5.2 Test results (maximum peak output power)

Ambient temperature	21 °C	Relative humidity	34 %
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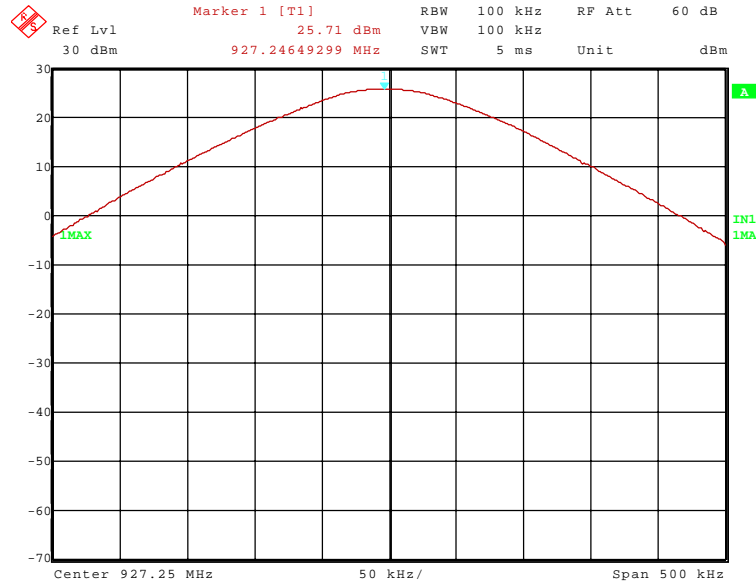
136258_24.wmf: Maximum peak output power at the low end of the assigned frequency band:



136258_25.wmf: Maximum peak output power at the middle of the assigned frequency band:



136258_26.wmf: Maximum peak output power at upper end of the assigned frequency band:



Operation mode	Channel number	Channel frequency [MHz]	Maximum peak output power [dBm]	Average output power [dBm]	Antenna gain [dBi]	Peak power limit [dBm]
1	1	902.750	25.7	24.5	4.2	30.0
2	25	914.750	26.0	25.0	4.2	30.0
3	50	927.250	25.7	24.8	4.2	30.0
Measurement uncertainty					+0.66 dB / -0.72 dB	

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

31

5.6 Radiated emissions

5.6.1 Method of measurement (Radiated emissions)

The radiated emission measurement is subdivided into four stages.

- A preliminary measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 9 kHz to 110 GHz.
- A final measurement carried out on an outdoor test site without reflecting ground plane and a fixed antenna height in the frequency range 9 kHz to 30 MHz.
- A final measurement carried out on an open area test site with reflecting ground plane and various antenna heights in the frequency range 30 MHz to 1 GHz.
- A final measurement carried out in a fully anechoic chamber with a fixed antenna height in the frequency range 1 GHz to 110 GHz.

All measurements will be carried out with the EUT working on the middle and upper and lower edge of the assigned frequency band. For this reason the hopping function of the EUT has to be disabled.

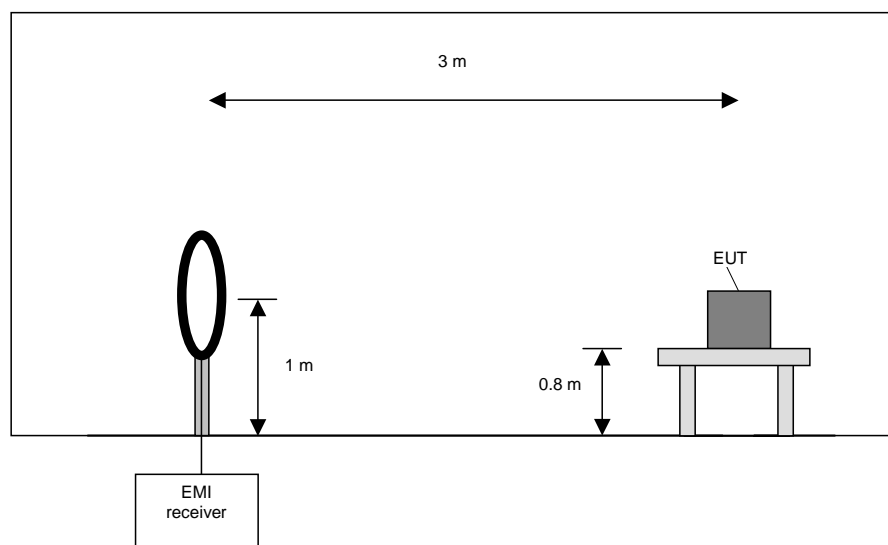
Preliminary measurement (9 kHz to 30 MHz):

In the first stage a preliminary measurement will be performed in a shielded room with a measuring distance of 3 meters. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set-up of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

The frequency range 9 kHz to 30 MHz will be monitored with a spectrum analyser while the system and its cables will be manipulated to find out the configuration with the maximum emission levels if applicable. The EMI Receiver will be set to MAX Hold mode. The EUT and the measuring antenna will be rotated around their vertical axis to found the maximum emissions.

The resolution bandwidth of the spectrum analyser will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



Preliminary measurement procedure:

Prescans were performed in the frequency range 9 kHz to 150 kHz, 150 kHz to 1 MHz and 1 MHz to 30 MHz.

The following procedure will be used:

- 1) Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
- 2) Manipulate the system cables within the range to produce the maximum level of emission.
- 3) Rotate the EUT by 360 ° to maximize the detected signals.
- 4) Make a hardcopy of the spectrum.
- 5) Measure the frequencies of highest detected emission with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
- 6) Repeat steps 1) to 5) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).
- 7) Rotate the measuring antenna and repeat steps 1) to 5).

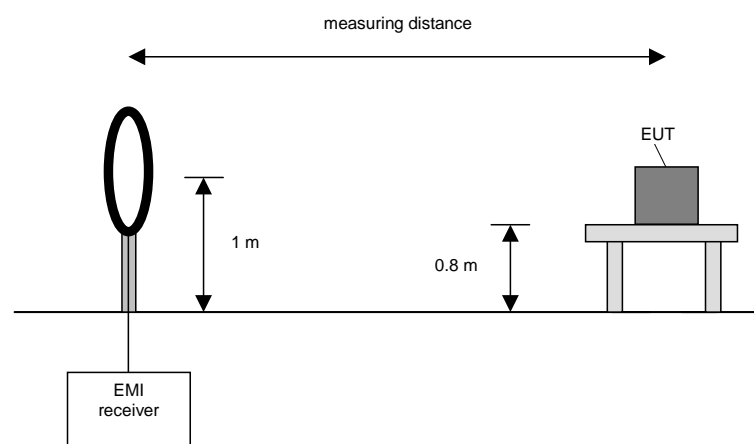
Final measurement (9 kHz to 30 MHz):

In the second stage a final measurement will be performed on an open area test site with no conducting ground plane with measuring distances of 3 m, 10 m and 30 m. In the case where larger measuring distances are required the results will be extrapolated based on the values measured on the closer distances according to Section 15.31 (f) (2) [2]. The final measurement will be performed with a EMI Receiver set to Quasi Peak detector except for the frequency bands 9 kHz to 90 kHz and 110 kHz to 490 kHz where an average detector will be used according Section 15.209 (d) [2].

On the during the preliminary measurement detected frequencies the final measurement will be performed while rotating the EUT and the measuring antenna in the range of 0 ° to 360 ° around their vertical axis until the maximum value is found.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
9 kHz to 150 kHz	200 Hz
150 kHz to 30 MHz	10 kHz



Final measurement procedure:

The following procedure will be used:

- 1) Monitor the frequency range with the measuring antenna at vertical orientation parallel to the EUT at an azimuth of 0 °.
- 2) Rotate the EUT by 360 ° to maximize the detected signals and note the azimuth and orientation.
- 3) Rotate the measuring antenna to find the maximum and note the value.
- 4) Rotate the measuring antenna and repeat steps 1) to 3) until the maximum value is found.
- 5) Repeat steps 1) to 4) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).

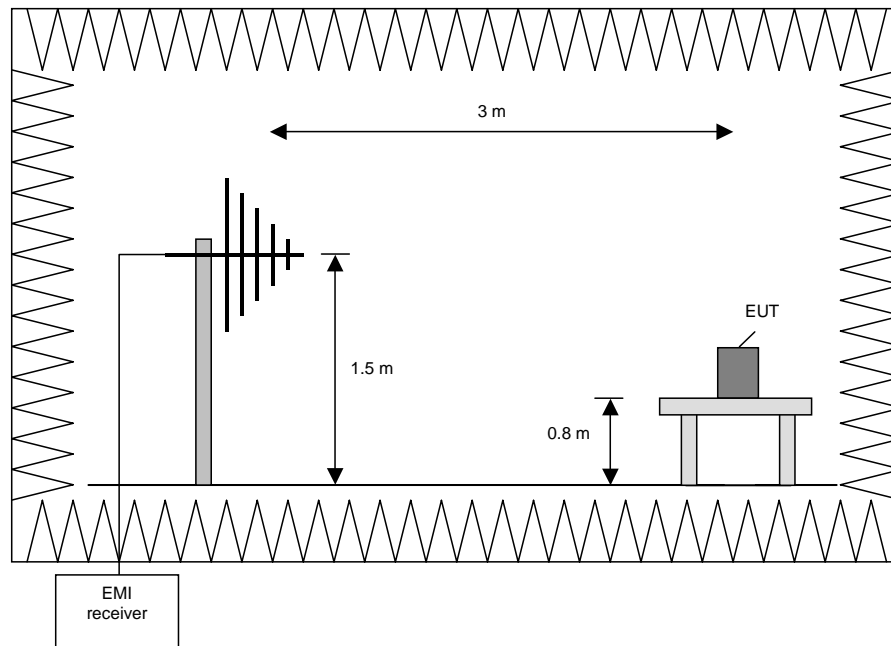
Preliminary measurement (30 MHz to 1 GHz)

In the first stage a preliminary measurement will be performed in a fully anechoic chamber with a measuring distance of 3 meter. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set-up of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

The frequency range 30 MHz to 1 GHz will be measured with an EMI Receiver set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 °.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 230 MHz	100 kHz
230 MHz to 1 GHz	100 kHz



Procedure preliminary measurement:

Prescans were performed in the frequency range 30 MHz to 230 MHz and 230 MHz to 1 GHz.

The following procedure will be used:

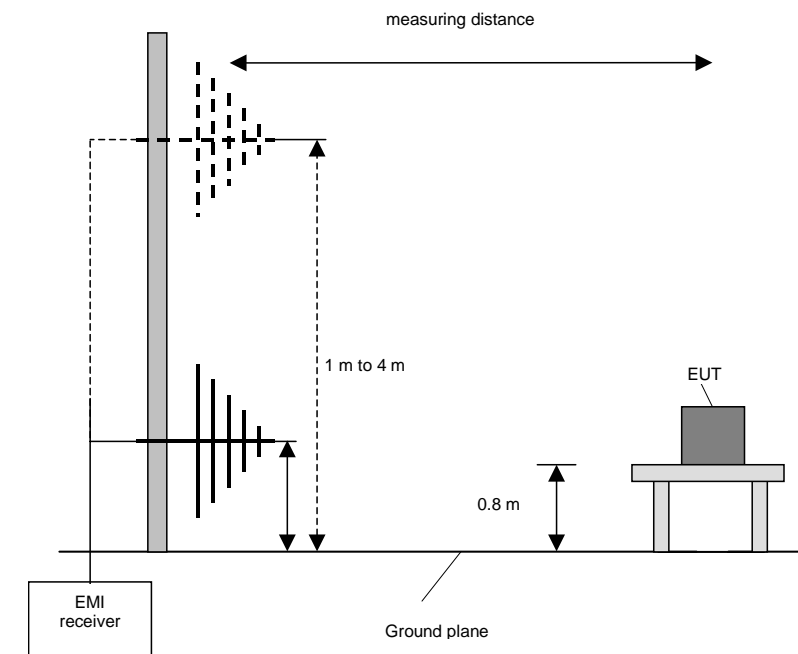
1. Monitor the frequency range at horizontal polarisation and a EUT azimuth of 0 °.
2. Manipulate the system cables within the range to produce the maximum level of emission.
3. Rotate the EUT by 360 ° to maximize the detected signals.
4. Make a hardcopy of the spectrum.
5. Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
6. Repeat 1) to 4) with the other orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).
7. Repeat 1) to 5) with the vertical polarisation of the measuring antenna.

Final measurement (30 MHz to 1 GHz)

A final measurement on an open area test site will be performed on selected frequencies found in the preliminary measurement. During this test the EUT will be rotated in the range of 0 ° to 360 °, the measuring antenna will be set to horizontal and vertical polarisation and raised and lowered in the range from 1 m to 4 m to find the maximum level of emissions.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
30 MHz to 1 GHz	120 kHz



Procedure final measurement:

The following procedure will be used:

- 1) Measure on the selected frequencies at an antenna height of 1 m and a EUT azimuth of 23 °.
- 2) Move the antenna from 1 m to 4 m and note the maximum value at each frequency.
- 3) Rotate the EUT by 45 ° and repeat 2) until an azimuth of 337 ° is reached.
- 4) Repeat 1) to 3) for the other orthogonal antenna polarization.
- 5) Move the antenna and the turntable to the position where the maximum value is detected.
- 6) Measure while moving the antenna slowly +/- 1 m.
- 7) Set the antenna to the position where the maximum value is found.
- 8) Measure while moving the turntable +/- 45 °.
- 9) Set the turntable to the azimuth where the maximum value is found.
- 10) Measure with Final detector (QP and AV) and note the value.
- 11) Repeat 5) to 10) for each frequency.
- 12) Repeat 1) to 11) for each orthogonal axes of the EUT (because of EUT is a module and might be used in a handheld equipment application).

Preliminary and final measurement (1 GHz to 110 GHz)

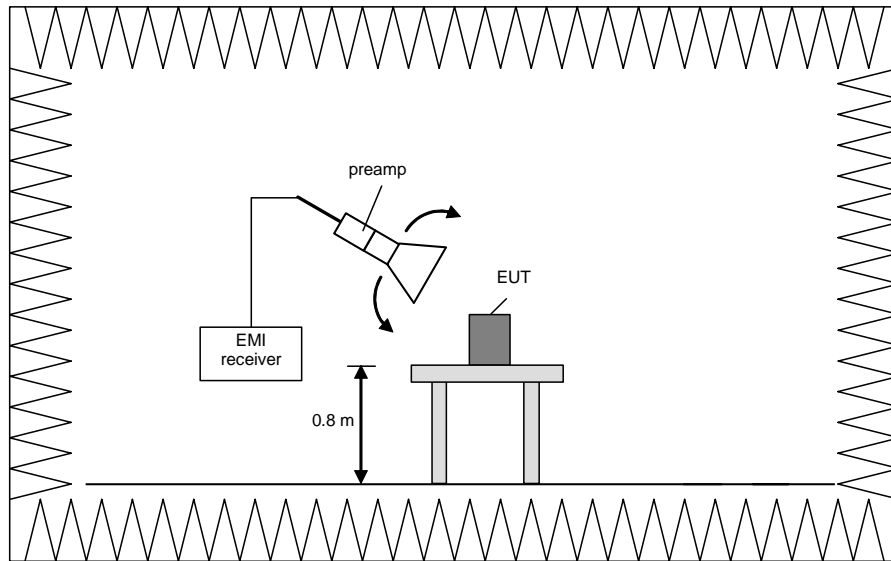
This measurement will be performed in a fully anechoic chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm. Floor-standing devices will be placed directly on the turntable/ground plane. The set-up of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

Preliminary measurement (1 GHz to 110 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The spectrum analyser set to MAX Hold mode and a resolution bandwidth of 100 kHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna, the antenna close to the EUT and while moving the antenna over all sides of the EUT. With the spectrum analyser in CLEAR / WRITE mode the cone of the emission should be found. Than the measuring distance will be set to 3 m with the receiving antenna moving in this cone of emission. At this position the final measurement will be carried out.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	100 kHz
4 GHz to 12 GHz	100 kHz
12 GHz to 18 GHz	100 kHz
18 GHz to 26.5 GHz	100 kHz
26.5 GHz to 40 GHz	100 kHz
40 GHz to 60 GHz	100 kHz
50 GHz to 75 GHz	100 kHz
75 GHz to 110 GHz	100 kHz

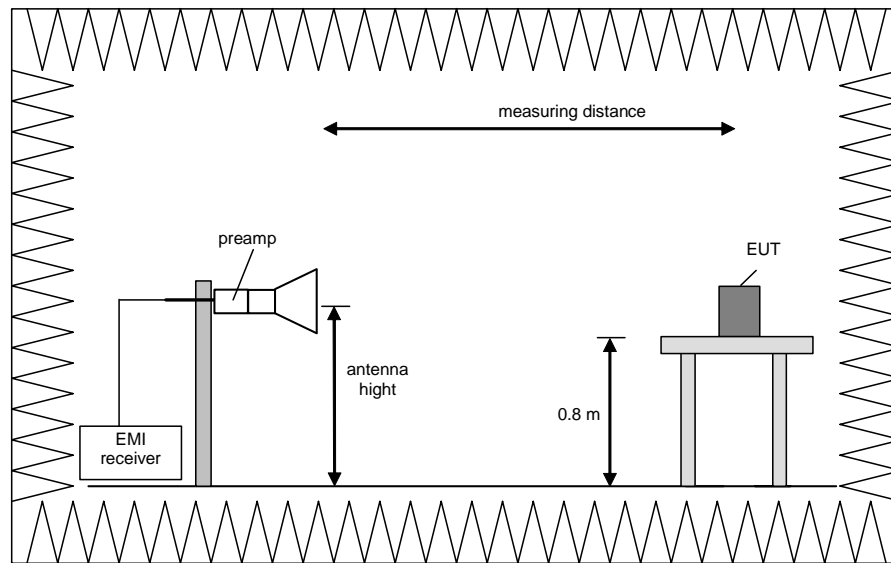


Final measurement (1 GHz to 110 GHz)

The frequency range will be divided into different sub ranges depending of the frequency range of the used horn antenna. The EMI Receiver set to peak and average mode and a resolution bandwidth of 1 MHz. The measurement will be performed in horizontal and vertical polarisation of the measuring antenna and while rotating the EUT in its vertical axis in the range of 0 ° to 360 ° in order to have the antenna inside the cone of radiation.

The resolution bandwidth of the EMI Receiver will be set to the following values:

Frequency range	Resolution bandwidth
1 GHz to 4 GHz	1 MHz
4 GHz to 12 GHz	1 MHz
12 GHz to 18 GHz	1 MHz
18 GHz to 26.5 GHz	1 MHz
26.5 GHz to 40 GHz	1 MHz
40 GHz to 60 GHz	1 MHz
50 GHz to 75 GHz	1 MHz
75 GHz to 110 GHz	1 MHz



Procedure of measurement:

The measurements were performed in the frequency range 1 GHz to 4 GHz, 4 GHz to 12 GHz, 12 GHz to 18 GHz, 18 GHz to 26.5 GHz, 26.5 GHz to 40 GHz, 40 GHz to 60 GHz, 60 GHz to 75 GHz and 75 GHz to 110 GHz.

The following procedure will be used:

- 1) Monitor the frequency range at horizontal polarisation and move the antenna over all sides of the EUT (if necessary move the EUT to another orthogonal axis).
- 2) Change the antenna polarisation and repeat 1) with vertical polarisation.
- 3) Make a hardcopy of the spectrum.
- 4) Measure the frequency of the detected emissions with a lower span and resolution bandwidth to increase the accuracy and note the frequency value.
- 5) Change the analyser mode to Clear / Write and found the cone of emission.
- 6) Rotate and move the EUT, so that the measuring distance can be enlarged to 3 m and the antenna will be still inside the cone of emission.
- 7) Measure the level of the detected frequency with the correct resolution bandwidth, with the antenna polarisation and azimuth and the peak and average detector, which causes the maximum emission.
- 8) Repeat steps 1) to 7) for the next antenna spot if the EUT is larger than the antenna beam width.

Step 1) to 6) are defined as preliminary measurement.

5.6.2 Test results (radiated emissions)

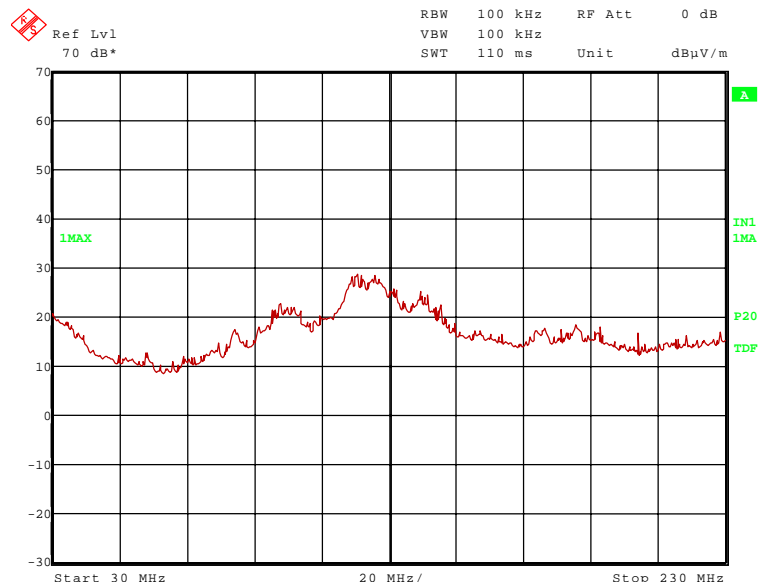
5.6.2.1 Preliminary radiated emission measurement

Ambient temperature	21 °C	Relative humidity	34 %
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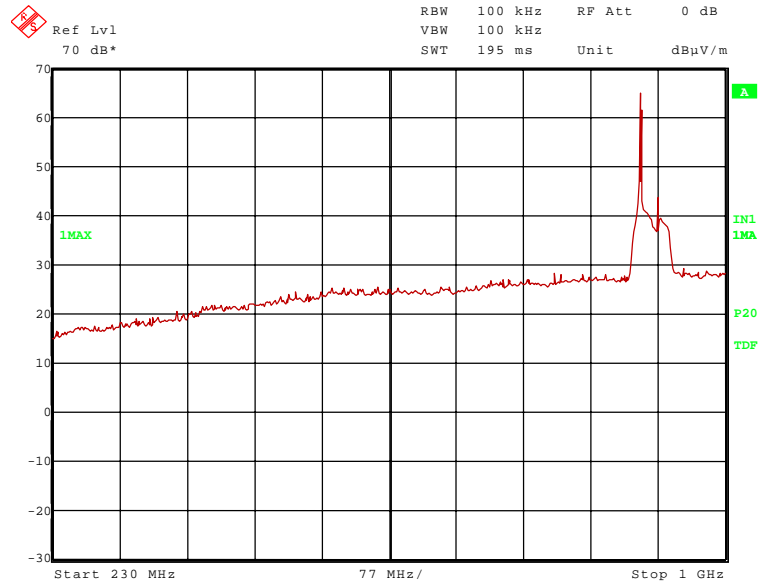
Position of EUT:	The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.
Cable guide:	For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.
Test record:	All results are shown in the following.
Supply voltage:	During all measurements the EUT was supplied with 24 V DC by an external power supply.
Remark:	As pre-tests have shown, the emissions in the frequency range 150 kHz to 30 MHz are not depending on the transmitter operation mode. Therefore the emissions in this frequency range were measured only with the transmitter operates in operation mode 2.

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)

136258_1.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 1):



136258_2.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 1, carrier notched):



The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

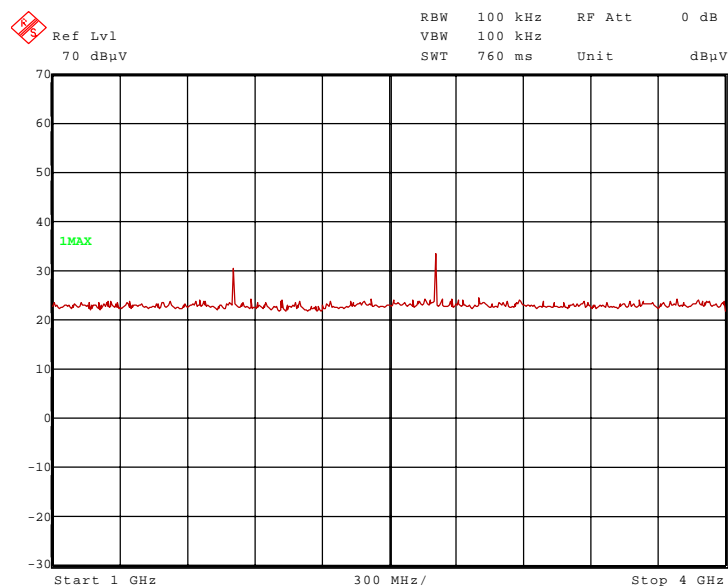
- 97.746 MHz, 139.445 MHz, 902.750 MHz, 922.750 MHz

The following frequency was found inside the restricted bands during the preliminary radiated emission test:

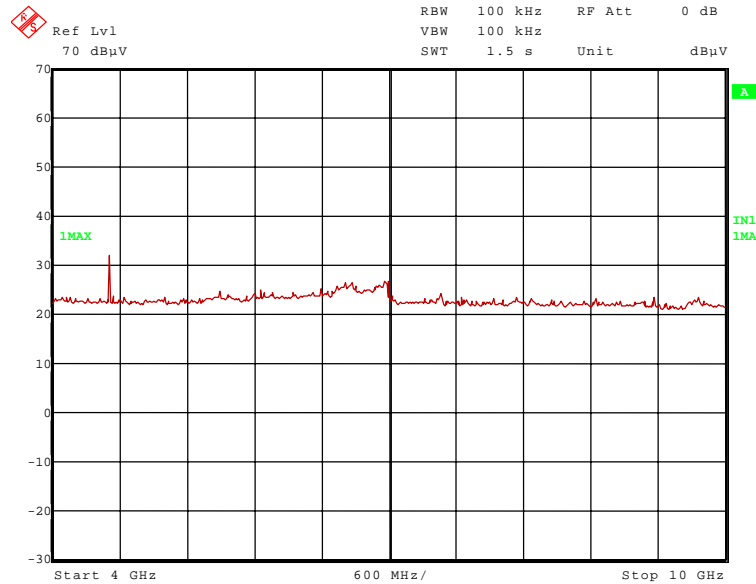
- 128.016 MHz.

These frequencies have to be measured on the open area test site. The result is presented in the following.

136258_12.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 1):



136258_13.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 1):



The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

- 2708.250 MHz and 4513.750 MHz.

The following frequency was found outside the restricted bands during the preliminary radiated emission test:

- 1805.500 MHz.

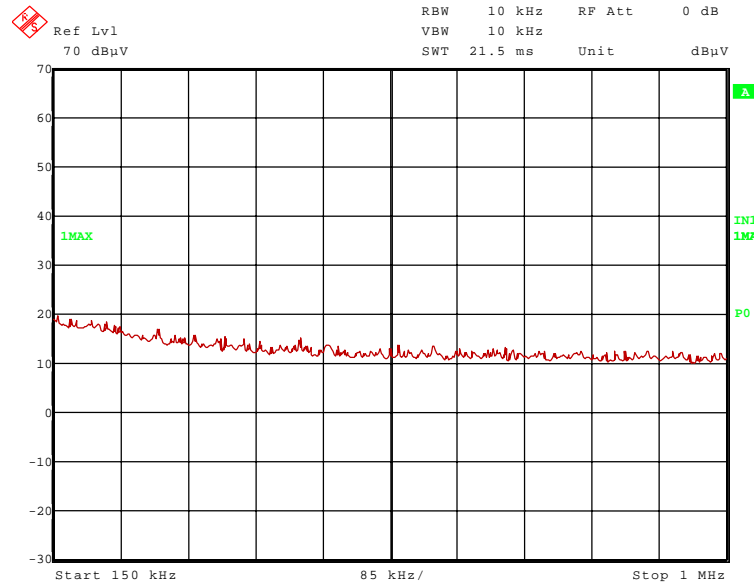
These frequencies have to be measured in a final measurement. The results were presented in the following.

TEST EQUIPMENT USED FOR THE TEST:

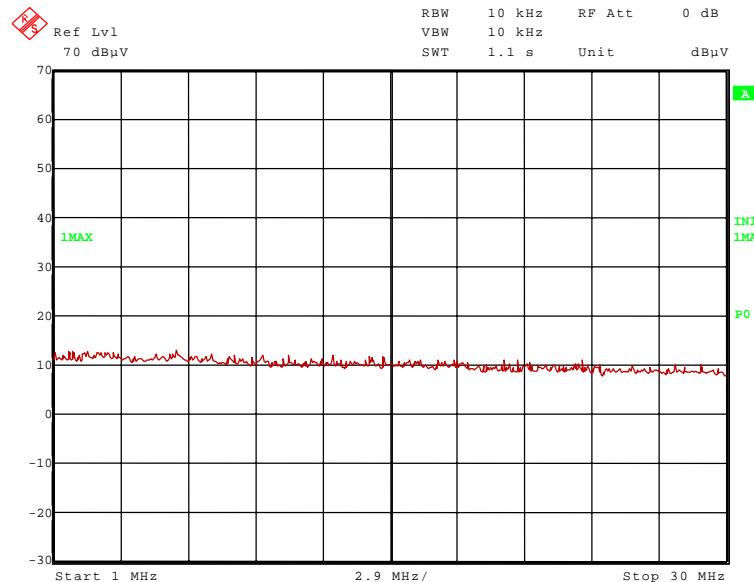
29, 31 - 36, 49, 55, 73, 75, 83, 124, 142, 143

Transmitter operates on the middle of the assigned frequency band (operation mode 2)

136258_14.wmf: Spurious emissions from 150 kHz to 1 MHz (operation mode 2):

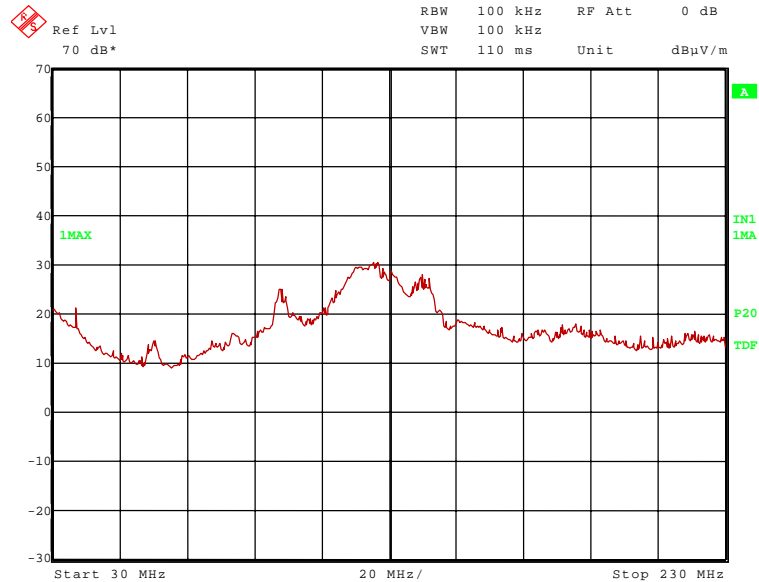


136258_15.wmf: Spurious emissions from 1 MHz to 30 MHz (operation mode 2):

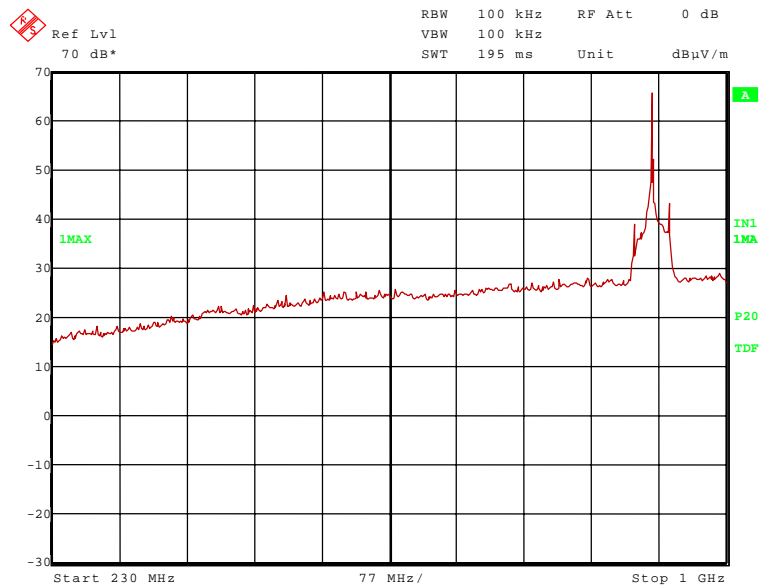


No significant frequencies above the noise floor of the system were found during the preliminary radiated emission test, so no measurements were carried out on the outdoor test site.

136258_3.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 2):



136258_4.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 2, carrier notched):



The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

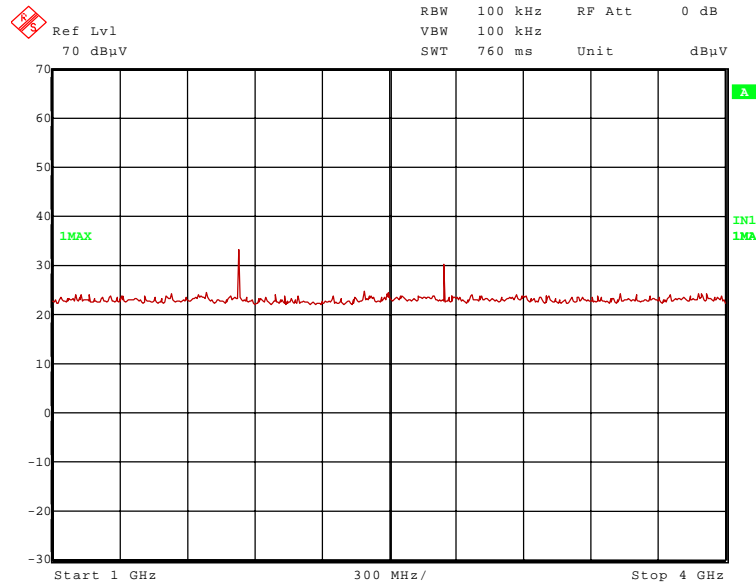
- 59.514 MHz, 97.701 MHz, 894.759 MHz, 914.750 and 934.739 MHz

The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

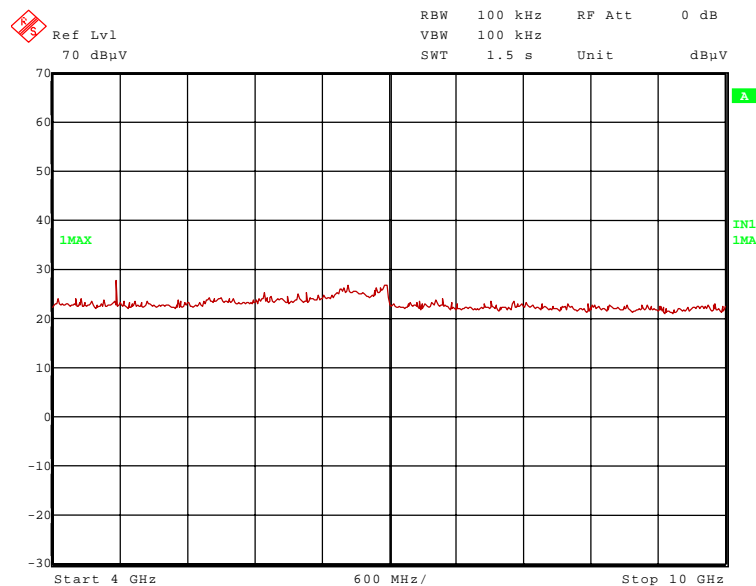
- 127.450 MHz and 132.396 MHz.

These frequencies have to be measured on the open area test site. The result is presented in the following.

136258_9.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 2):



136258_11.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 2):



The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

- 2744.250 MHz and 4573.750 MHz.

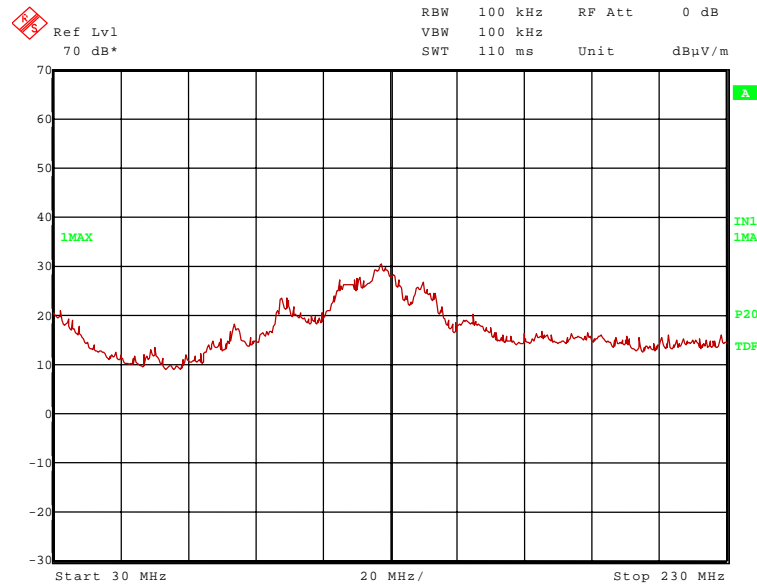
The following frequency was found outside the restricted bands during the preliminary radiated emission test:

- 1829.500 MHz.

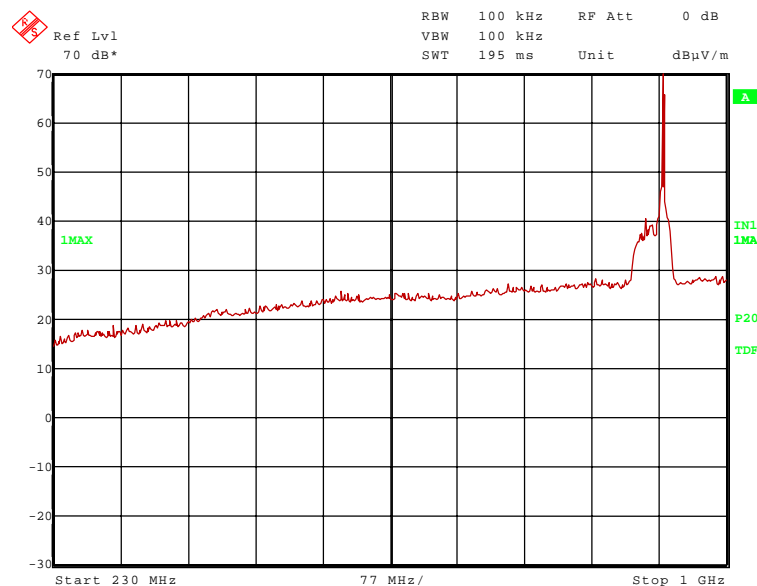
These frequencies have to be measured in a final measurement. The results were presented in the following.

Transmitter operates on the upper end of the assigned frequency (operation mode 3)

136258_5.wmf: Spurious emissions from 30 MHz to 230 MHz (operation mode 3):



136258_6.wmf: Spurious emissions from 230 MHz to 1 GHz (operation mode 3, carrier notched):



The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

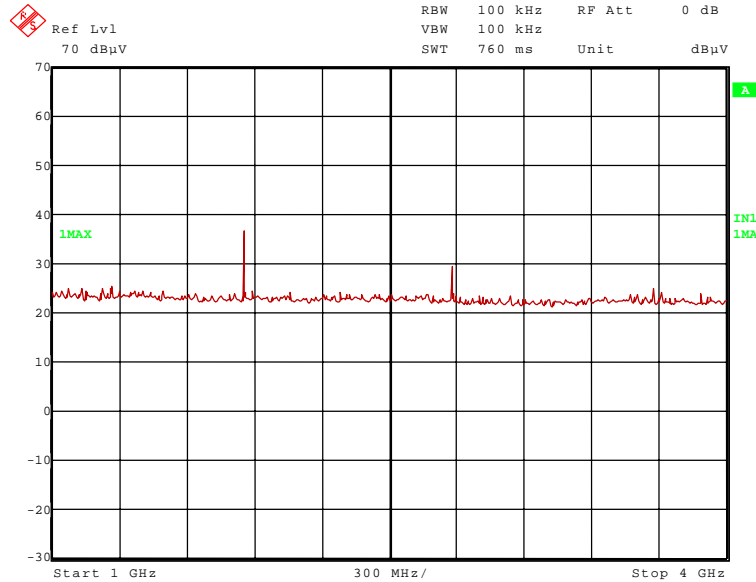
- 83.271 MHz, 97.209 MHz, 139,340 MHz, 907.245 MHz and 927.250 MHz.

The following frequency was found inside the restricted bands during the preliminary radiated emission test:

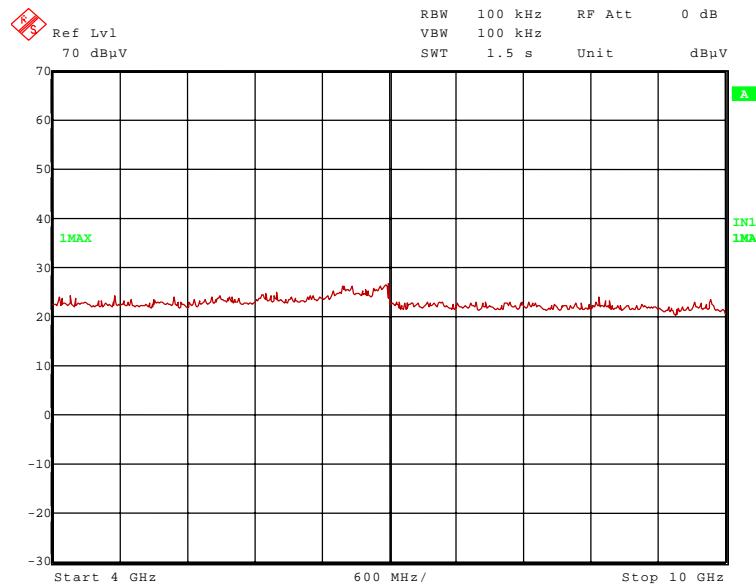
- 120.947 MHz.

These frequencies have to be measured on the open area test site. The result is presented in the following.

136258_7.wmf: Spurious emissions from 1 GHz to 4 GHz (operation mode 3):



136258_8.wmf: Spurious emissions from 4 GHz to 10 GHz (operation mode 3):



The following frequencies were found inside the restricted bands during the preliminary radiated emission test:

- 2781.750 MHz and 3709.000 MHz.

The following frequencies were found outside the restricted bands during the preliminary radiated emission test:

- 1854.500 MHz.

These frequencies have to be measured in a final measurement. The results were presented in the following.

5.6.2.2 Final radiated emission measurement (30 MHz to 1 GHz)

Ambient temperature	21 °C	Relative humidity	33 %
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Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 24 V DC by an external power supply.

Test results: The test results were calculated with the following formula:

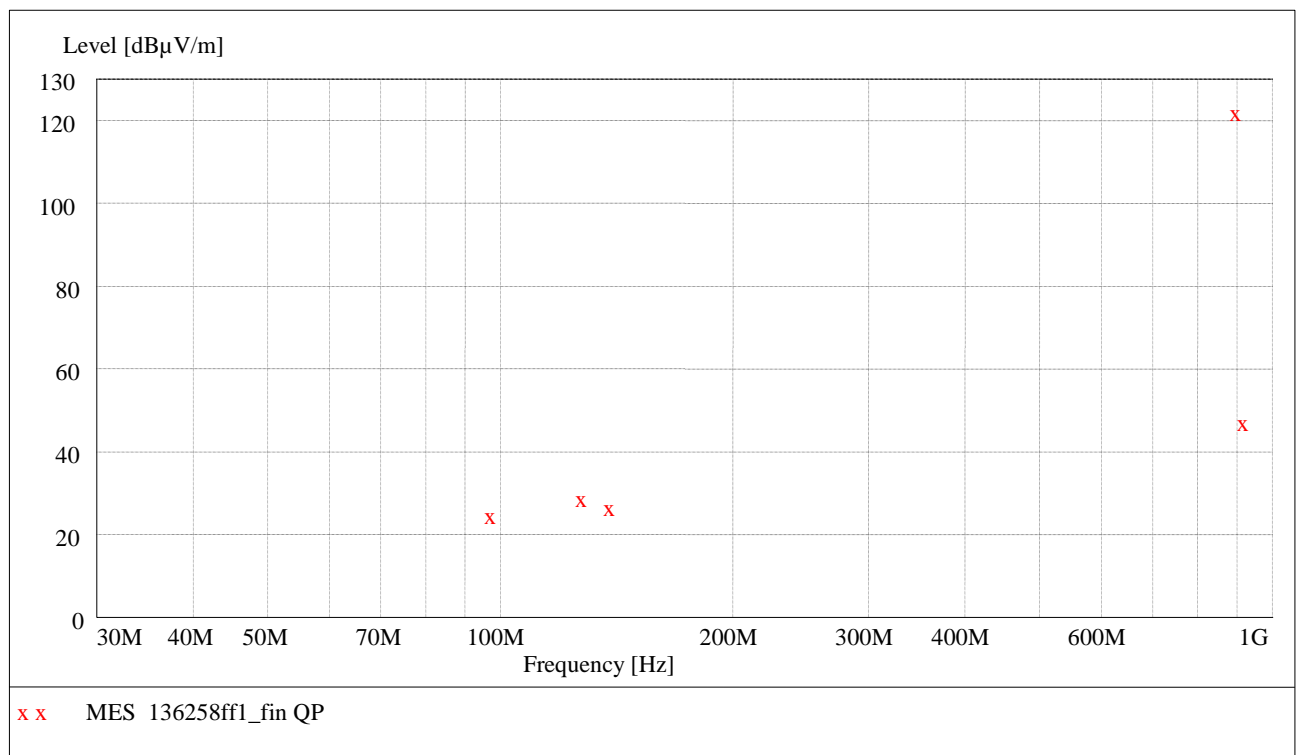
$$\text{Result [dB}\mu\text{V/m]} = \text{reading [dB}\mu\text{V]} + \text{cable loss [dB]} + \text{antenna factor [dB/m]}$$

The measured points and the limit line in the following diagrams refer to the standard measurement of the emitted interference in compliance with the above-mentioned standard. The measured points marked with an x are the measured results of the standard final measurement on the open area test site.

The results of the standard subsequent measurement on the open area test site are indicated in the table below. The limits as well as the measured results (levels) refer to the above mentioned standard while taking account of the specified requirements for a 3 m measuring distance.

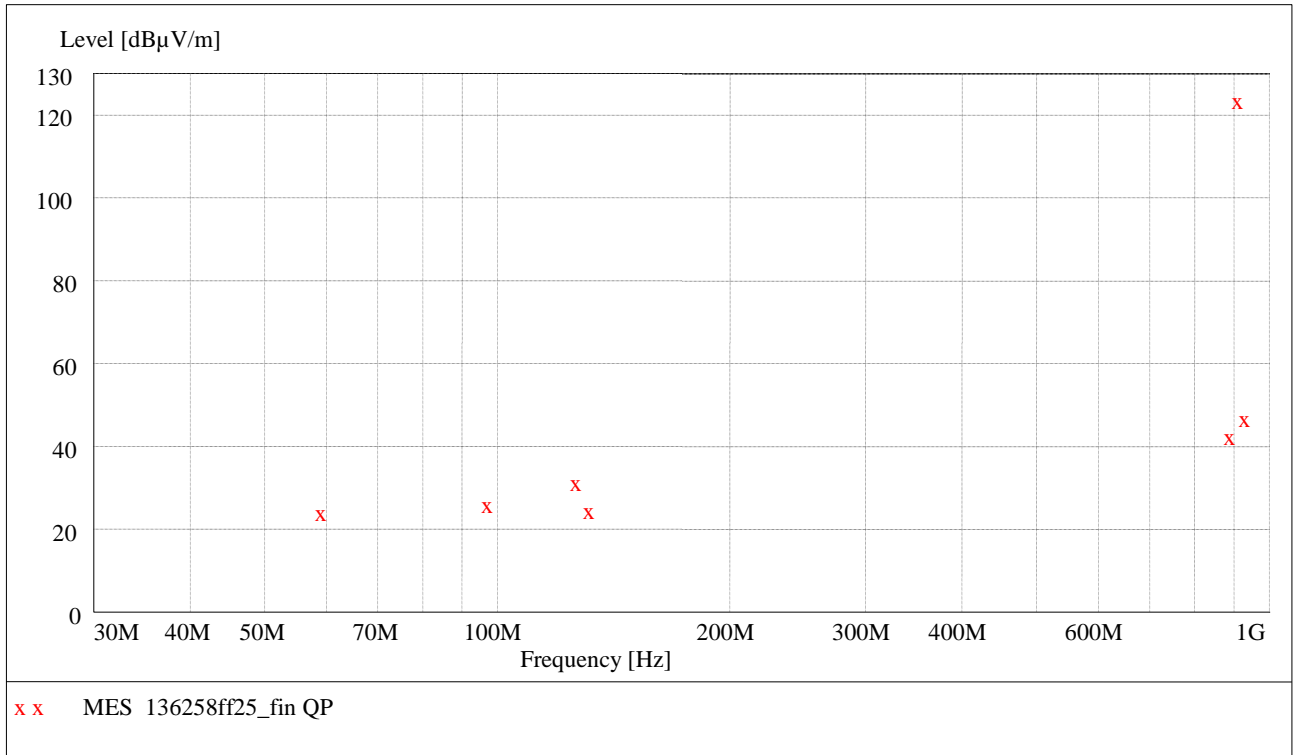
The measurement time with the quasi-peak measuring detector is 1 second.

Transmitter operates on the lower end of the assigned frequency (operation mode 1)



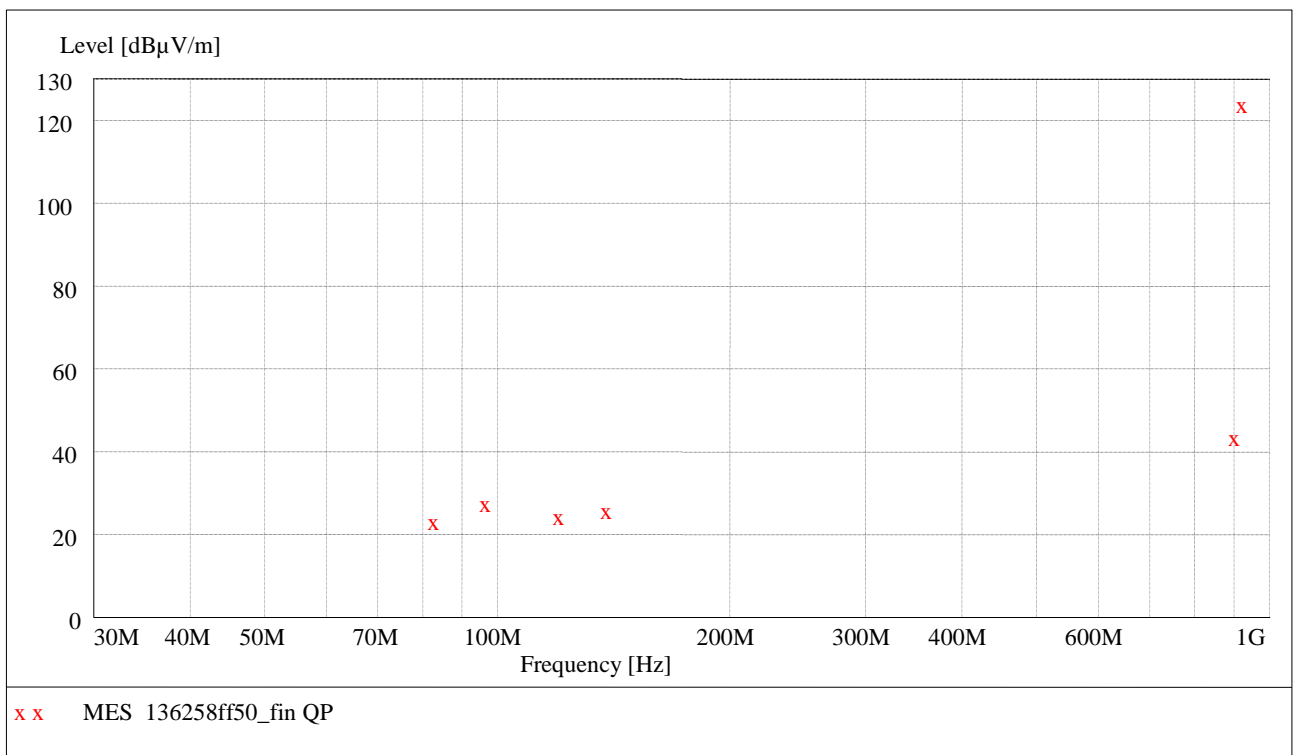
Data record name: 136258ff1

Transmitter operates on the middle of the assigned frequency (operation mode 2)



Data record name: 136258ff25

Transmitter operates on the upper end of the assigned frequency (operation mode 3)



Data record name: 136258ff50

Result measured with the quasi-peak detector:
(These values were marked in the diagrams by an x)

Transmitter operates on the lower end of the assigned frequency band (operation mode 1)									
Spurious emissions outside restricted bands									
Frequency	Result	Limit	Margin	Readings	Antenna factor	Cable loss	Height	Azimuth	Pol.
MHz	dB μ V/m	dB μ V/m	dB	dB μ V	dB/m	dB	cm	deg	
97.746	25.4	102.7	77.3	13.7	10.6	1.1	325.0	108.0	Hor.
139.445	27.2	102.7	75.5	13.9	12.0	1.3	210.0	270.0	Hor.
902.750	122.7	Carrier	-	96.8	22.5	3.4	204.0	341.0	Hor.
922.750	47.7	102.7	55.0	21.1	23.2	3.4	181.0	0.0	Hor.
Spurious emissions inside restricted bands									
Frequency	Result	Limit	Margin	Readings	Antenna factor	Cable loss	Height	Azimuth	Pol.
MHz	dB μ V/m	dB μ V/m	dB	dB μ V	dB/m	dB	cm	deg	
128.016	29.3	43.5	14.2	15.7	12.3	1.3	325.0	189.0	Vert.
Transmitter operates on the middle of the assigned frequency band (operation mode 2)									
Spurious emissions outside restricted bands									
Frequency	Result	Limit	Margin	Readings	Antenna factor	Cable loss	Height	Azimuth	Pol.
MHz	dB μ V/m	dB μ V/m	dB	dB μ V	dB/m	dB	cm	deg	
59.514	24.7	104.1	79.4	17.5	6.3	0.9	100.0	23.0	Vert.
97.701	26.7	104.1	77.4	15.0	10.6	1.1	336.0	226.0	Hor.
894.759	43.1	104.1	61.0	17.4	22.2	3.5	204.0	341.0	Hor.
914.750	124.1	Carrier	-	97.9	22.8	3.4	179.0	0.0	Hor.
934.739	47.5	104.1	56.6	20.5	23.6	3.4	181.0	348.0	Hor.
Spurious emissions inside restricted bands									
Frequency	Result	Limit	Margin	Readings	Antenna factor	Cable loss	Height	Azimuth	Pol.
MHz	dB μ V/m	dB μ V/m	dB	dB μ V	dB/m	dB	cm	deg	
127.450	32.0	43.5	11.5	18.4	12.3	1.3	235.0	91.0	Hor.
132.396	25.2	43.5	18.3	11.8	12.1	1.3	225.0	136.0	Hor.
Transmitter operates on the upper end of the assigned frequency band (operation mode 3)									
Spurious emissions outside restricted bands									
Frequency	Result	Limit	Margin	Readings	Antenna factor	Cable loss	Height	Azimuth	Pol.
MHz	dB μ V/m	dB μ V/m	dB	dB μ V	dB/m	dB	cm	deg	
83.271	24.0	104.4	80.4	14.4	8.6	1.0	140.0	1.0	Vert.
97.209	28.1	104.4	76.3	16.5	10.5	1.1	330.0	125.0	Hor.
139.340	26.5	104.4	77.9	13.2	12.0	1.3	214.0	270.0	Hor.
907.245	44.1	104.4	60.3	18.2	22.5	3.4	204.0	341.0	Hor.
927.250	124.4	Carrier	-	97.6	23.4	3.4	179.0	342.0	Hor.
Spurious emissions inside restricted bands									
Frequency	Result	Limit	Margin	Readings	Antenna factor	Cable loss	Height	Azimuth	Pol.
MHz	dB μ V/m	dB μ V/m	dB	dB μ V	dB/m	dB	cm	deg	
120.947	25.1	43.5	18.4	11.5	12.4	1.2	326.0	189.0	Vert.
Measurement uncertainty				+2.2 dB / -3.6 dB					

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

2, 14, 16 - 20

5.6.2.3 Final radiated emission measurement (1 GHz to 10 GHz)

Ambient temperature	21 °C	Relative humidity	34 %
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Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m. The distance between EUT and antenna was 3 m.

Cable guide: For detail information of test set-up and the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 24 V DC by an external power supply.

Resolution bandwidth: For all measurements a resolution bandwidth of 1 MHz was used.

Transmitter operates at the lower end of the assigned frequency band (operation mode 1)

Result measured with the peak detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1805.500	37.6	102.7	65.1	34.6	26.5	26.5	3.0	150	Hor.	No
2708.250	43.7	74.0	30.3	37.4	28.7	26.4	4.0	150	Hor.	Yes
4513.750	46.9	74.0	27.1	35.3	32.3	25.8	5.1	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1805.500	30.0	102.7	72.7	27.0	26.5	26.5	3.0	150	Hor.	No
2708.250	37.8	54.0	16.2	31.5	28.7	26.4	4.0	150	Hor.	Yes
4513.750	41.8	54.0	12.2	30.2	32.3	25.8	5.1	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Transmitter operates at the middle of the assigned frequency band (operation mode 2)

Result measured with the peak detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1829.500	39.8	104.1	64.3	36.3	26.7	26.5	3.3	150	Hor.	No
2744.250	41.4	74.0	32.6	34.8	28.9	26.4	4.1	150	Hor.	Yes
4573.750	44.9	74.0	29.1	33.2	32.4	25.8	5.1	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1829.500	33.5	104.1	70.6	30.0	26.7	26.5	3.3	150	Hor.	No
2744.250	32.9	54.0	21.1	26.3	28.9	26.4	4.1	150	Hor.	Yes
4573.750	36.4	54.0	17.6	24.7	32.4	25.8	5.1	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Transmitter operates at the upper end of the assigned frequency band (operation mode 3)

Result measured with the peak detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1854.500	42.8	104.4	61.6	38.7	27.0	26.5	3.6	150	Hor.	No
2781.750	40.6	74.0	33.4	33.9	29.0	26.4	4.1	150	Vert.	Yes
3709.000	41.2	74.0	32.8	31.0	31.8	26.2	4.6	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Result measured with the average detector:

Frequency MHz	Corr. Value dB μ V/m	Limit dB μ V/m	Margin dB	Readings dB μ V	Antenna factor 1/m	Preamp dB	Cable loss dB	Height cm	Pol.	Restr. Band
1854.500	36.9	104.4	67.5	32.8	27.0	26.5	3.6	150	Hor.	No
2781.750	30.6	54.0	23.4	23.9	29.0	26.4	4.1	150	Vert.	Yes
3709.000	29.7	54.0	24.3	19.5	31.8	26.2	4.6	150	Hor.	Yes
Measurement uncertainty							+2.2 dB / -3.6 dB			

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

29, 31 - 34, 36, 49, 73, 75, 124, 143

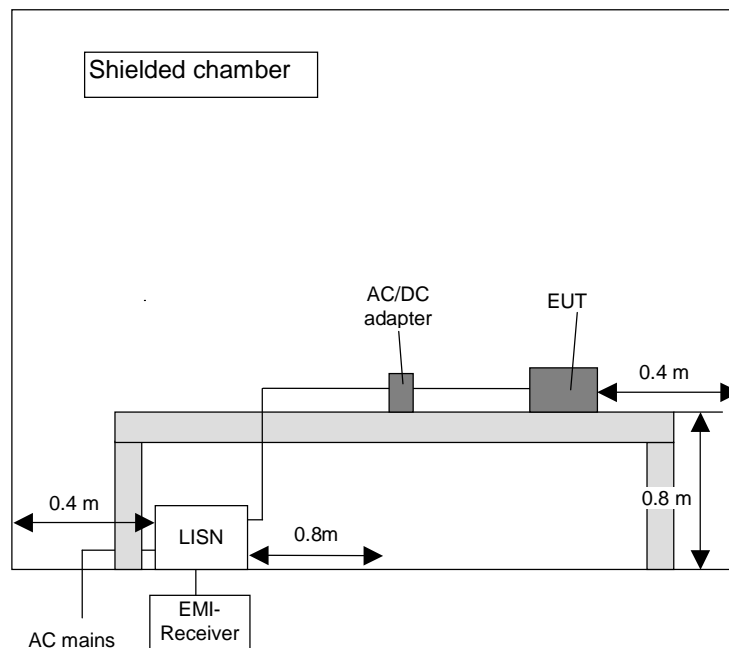
5.7 Conducted emissions on power supply lines (150 kHz to 30 MHz)

5.7.1 Method of measurement

This test will be carried out in a shielded chamber. Tabletop devices will set up on a non-conducting support with a size of 1 m by 1.5 m and a height of 80 cm above the ground plane. Floor-standing devices will be placed directly on the ground plane. The set-up of the Equipment under test will be in accordance to ANSI C63.4-2009 [1].

The frequency range 150 kHz to 30 MHz will be measured with an EMI Receiver set to MAX Hold mode with peak and average detector and a resolution bandwidth of 9 kHz. A scan will be carried out on the phase (or plus pole in case of DC powered devices) of the AC mains network. If levels detected 10 dB below the appropriate limit, this emission will be measured with the average and quasi-peak detector on all lines.

Frequency range	Resolution bandwidth
150 kHz to 30 MHz	9 kHz



5.7.2 Test results (conducted emissions on power supply lines)

Ambient temperature	21 °C	Relative humidity	33 %
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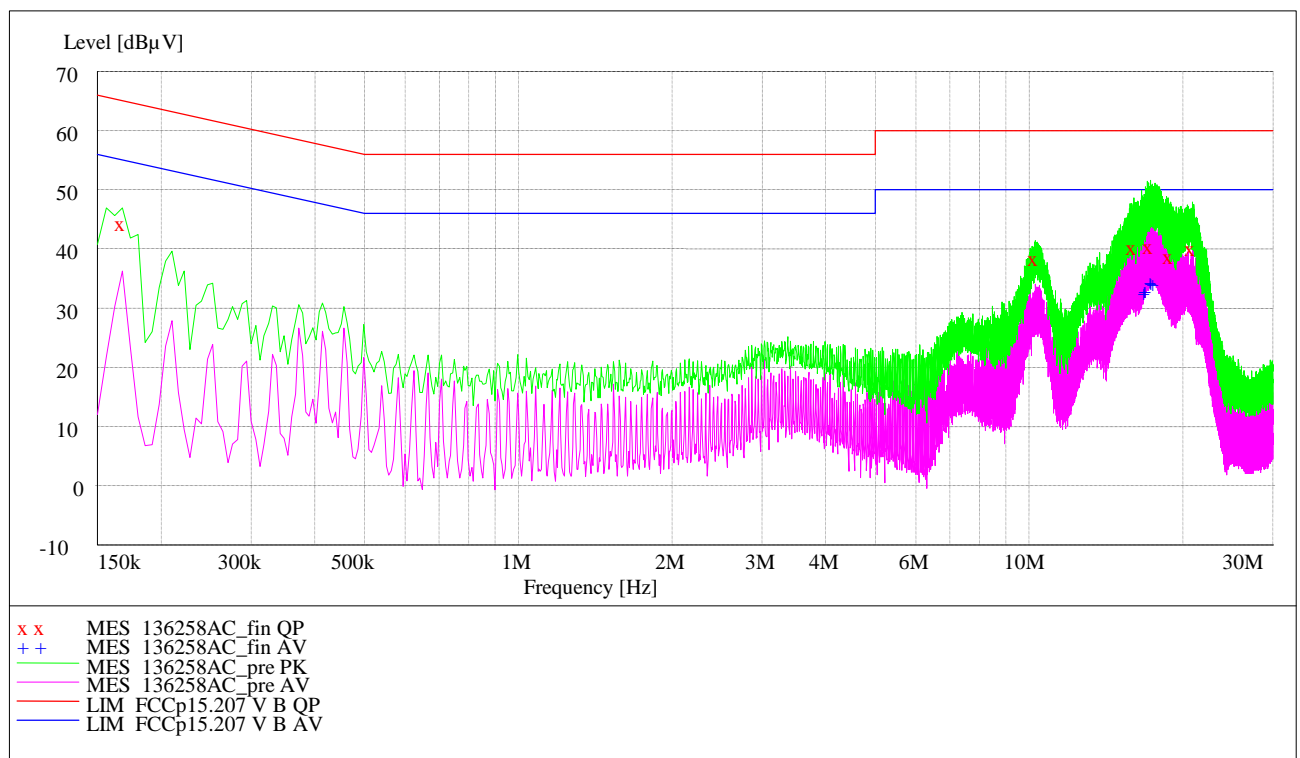
Position of EUT: The EUT was set-up on a non-conducting table of a height of 0.8 m.

Cable guide: The cables of the EUT were fixed on the non-conducting table. For further information of the cable guide refer to the pictures in annex A of this test report.

Test record: All results are shown in the following.

Supply voltage: During all measurements the EUT was supplied with 24.0 V DC by an AC / DC adaptor type MINI-PS-100-240AC/24DC/1, which was supplied by 120 V AC / 60 Hz.

The curves in the diagram only represent for each frequency point the maximum measured value of all preliminary measurements, which were made for each power supply line. The top measured curve represents the peak measurement and the bottom measured curve the average measurement.



Data record name: 136258AC

Result measured with the quasi-peak detector (marked in the diagram by an x):

Frequency MHz	Level dB μ V	Transducer dB	Limit dB μ V	Margin dB	Line	PE
0.168	44.8	1.3	65.1	20.3	N	GND
10.302	38.9	1.4	60.0	21.1	L1	GND
16.038	40.7	2.0	60.0	19.3	N	GND
17.292	40.8	2.1	60.0	19.2	N	GND
18.906	39.2	2.3	60.0	20.8	L1	FLO
20.862	40.5	2.5	60.0	19.5	L1	FLO

Result measured with the average detector (marked in the diagram by a +):

Frequency MHz	Level dB μ V	Transducer dB	Limit dB μ V	Margin dB	Line	PE
16.956	33.1	2.1	50.0	16.9	N	GND
16.998	33.4	2.1	50.0	16.6	N	FLO
17.040	33.4	2.1	50.0	16.6	N	GND
17.454	35.0	2.1	50.0	15.0	N	FLO
17.496	34.8	2.1	50.0	15.2	N	FLO
17.622	34.6	2.1	50.0	15.4	N	FLO

Test: Passed

TEST EQUIPMENT USED FOR THE TEST:

1 - 4, 20

6 Test equipment and ancillaries used for tests

No.	Test equipment	Type	Manufacturer	Serial No.	PM. No.	Cal. Date	Cal. due
1	Shielded chamber M47	-	Albatross Projects	B83117-C6439-T262 -	480662	Weekly verification (system cal.)	
2	EMI Receiver	ESIB 26	Rohde & Schwarz	1088.7490	481182	03/09/2012	03/2014
3	LISN	NSLK8128	Schwarzbeck	8128161	480138	12/20/2013	12/2014
4	High pass filter	HR 0.13-5ENN	FSY Microwave Inc.	DC 0109 SN 002	480340	Weekly verification (system cal.)	
14	Open area test site	-	Phoenix Test-Lab	-	480085	Weekly verification (system cal.)	
16	Controller	HD100	Deisel	100/670	480139	-	-
17	Turntable	DS420HE	Deisel	420/620/80	480087	-	-
18	Antenna support	AS615P	Deisel	615/310	480086	-	-
19	Antenna	CBL6111 D	Chase	25761	480894	09/28/2011	09/2014
20	EMI Software	ES-K1	Rohde & Schwarz	-	480111	-	-
29	Fully anechoic chamber M20	-	Albatross Projects	B83107-E2439-T232	480303	Weekly verification (system cal.)	
31	Measuring receiver	ESI 40	Rohde & Schwarz	100064	480355	02/13/2012	02/2014
32	Controller	MCU	Maturo	MCU/043/971107	480832	-	-
33	Turntable	DS420HE	Deisel	420/620/80	480315	-	-
34	Antenna support	AS615P	Deisel	615/310	480187	-	-
35	Antenna	CBL6112 B	Chase	2688	480328	04/21/2011	04/2014
36	Antenna	3115 B	EMCO	9609-4922	480184	09/28/2011	09/2014
43	RF-cable No. 30	RTK 081	Rosenberger	-	410141	Weekly verification (system cal.)	
44	RF-cable No. 31	RTK 081	Rosenberger	-	410142	Weekly verification (system cal.)	
49	Preamplifier	JS3-00101200-23-5A	Miteq	681851	480337	Six month verification (system cal.)	
55	Loop antenna	HFH2-Z2	Rohde & Schwarz	832609/014	480059	02/16/2012	02/2014
73	High Pass Filter	WHJS1000C 11/60EF	Wainwright Instruments GmbH	1	480413	Weekly verification (system cal.)	
75	High Pass Filter	WHKX4.0/18 G-8SS	Wainwright Instruments GmbH	1	480587	Weekly verification (system cal.)	
83	Tuneable Notch Filter	WRCA800/90 0-0.2/40-6EEK	Wainwright Instruments GmbH	15	480414	Weekly verification (system cal.)	
124	RF-cable No. 3	Sucoflex 106B	Suhner	0563/6B	480670	Weekly verification (system cal.)	
142	RF-cable No. 36	Sucoflex 106B	Suhner	500003/6B	481680	Weekly verification (system cal.)	
143	RF-cable No. 40	Sucoflex 106B	Suhner	0708/6B	481330	Weekly verification (system cal.)	

